LEAF VENATION STUDIES IN INDIAN *SIDA* (MALVACEAE)

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ABSTRACT

In *Sida* L., the leaves are simple having serrate margins, except *S. schimperiana*, where the leaves have entire margins. The venation type is pinnate or actinodromous. The leaf shape, apex, base, number of areoles and the vein endings entering the areoles vary from species to species. The highest degree of vein order is resolved up to fifth degree. Vein endings exhibit brachytracheoids as well as tracheoids-in-aggregates.

INTRODUCTION

Recent studies on leaf architecture of dicotyledons by Hickey (1973, 1979) have created much interest and led to several investigations in this field. Many workers also concluded that the venation studies provide useful taxonomic clues in different taxa (Foster 1950, 1951; Tucker 1964; Banerji & Das 1972; Hickey 1973, 1979; Sehgal & Paliwal 1974; Prabhaker & Ramayya 1982; Samant & Shete 1987; Bhat et al. 1988). However, work on foliar venation in the Malvaceae is negligible (Hickey & Wolfe 1975; Bhat et al. 1988) and totally absent in *Sida*. Therefore, in the present investigation, nine taxa of *Sida* have been studied concerning the leaf morphology and venation patterns to fill in this void.

MATERIALS AND METHODS

The materials of *Sida* studied have been collected from different parts of India (Table 1). The mature leaves were first cleared in 50% sodium hypochlorite for 4 − 5 hours and later transferred to a supersaturated solution of chloral hydrate for a day. However, the dry leaves were boiled in 5% sodium hydroxide for 5 − 10 minutes before clearing by the above method. The leaves were stained in safranin and mounted in glycerin. The areole and veinlet frequencies/mm^2 were calculated from an average of 10 readings. The sizes of veins were calculated from the formula vw/lw × 100 (Hickey 1973). Terms to describe the venation and vein endings were

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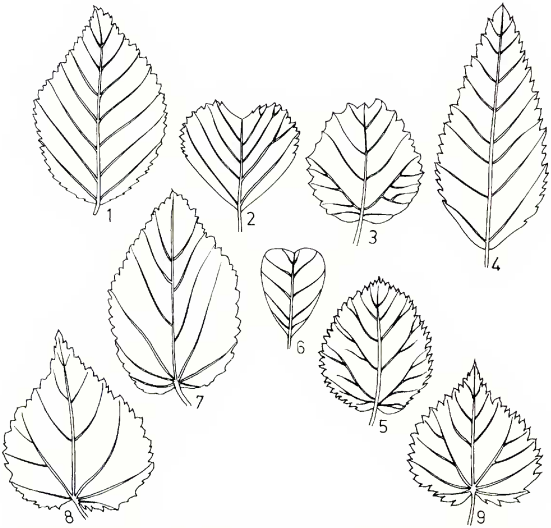
adopted from Hickey (1973), Hickey & Wolfe (1975) and those of tracheoids from Rao & Das (1979).

OBSERVATIONS

The leaves of *Sida* are simple, symmetrical with a range of leaf shapes from lanceolate, orbicular to obovate (Figs. 1—9). The apex also varies from acute, acuminate to obovate and emarginate (Figs. 1—9). Correspondingly, the leaf base varies from rounded, cuneate to obtuse and acute. The qualitative and quantitative features of leaf venation in the nine taxa of *Sida* are given in Table 1.

The venation patterns encountered in the present study are as follows: *S. rhombifolia* var. *rhombifolia*, *S. rhombifolia* var. *retusa*, *S. grewioides*, *S. acuta* and *S. spinosa* (Figs. 1—5) exhibit pinnate eucamptodromous type, but *S.*



FIGS. 1—9: 1. *S. rhombifolia* var. *rhombifolia*, 2. *S. rhombifolia* var. *retusa*; 3. *S. grewioides*; 4. *S. acuta*; 5. *S. spinosa*; 6. *S. schimperiana*, 7. *S. cordifolia*; 8. *S. mysorensis*; 9. *S. cordata*. All figures × 0.79.

Table 1. *Sida* species collected and studied.

S.L No.	Name of Species	Locality	Shape	Apex	Base	Margin	Texture	Predominate Tert. Vein origin Angle	Marginal Ultimate Venation	No. of 1° Veins	No. of 2° Veins	Angle range between 1° & 2°	Areoles/ mm^2	No of Vein endings/ mm^2	Vein pattern
1.	*S. acuta* Burm. f.	Hyderabad	Lanceolate	Acute to acuminate	Rounded	Serrate	Charraceous	RR	Incomplete and looped	1	8	Lower pair obtuse, upper acute	88	40	Pinnate, eucamptodromous
2.	*S. cordata* Burm. f. Borss.	Hyderabad	Orbicular	-do-	Cordate	-do-	-do-	-do-	-do-	5	8	Acute	20	6	Actinodromous
3.	*S. cordifolia* L.	Hyderabad	Obovate	Obtuse	-do-	-do-	-do-	-do-	-do-	7	6	-do-	51	24	-do-
4.	*S. grewioides* Guill. & Pers.	Aurangabad	Ovate	Obtuse	Rounded	-do-	-do-	-do-	-do-	1	8	Lower secondaries more acute than upper pairs	52	24	Pinnate, eucamptodromous
5.	*S. mysorensis* W & A.	Bangalore	Ovate	Acute	Cordate	-do-	-do-	-do-	-do-	6	8	-do-	50	8	Actinodromous
6.	*S. rhombifolia* var. *rhombifolia* L.	New Delhi	Obovate-rounded, rhomboid elliptic	Acute to acuminate	Cuneate or rounded	-do-	-do-	RR/AR	Looped	1	6	-do-	36	12	Pinnate, eucamptodromous
7.	*S. rhombifolia* var. *retusa* L.	Chittoor, A P	Obovate linear	Emarginate	Acute	-do-	-do-	-do-	-do	1	8	-do-	19	6	-do-
8.	*S. schimperiana* Hochst.	B.S.I. S. Circle	Obovate	-do-	-do-	entire	-do-	-do-	Looped and incomplete	1	4	-do-	132	74	Pinnate, brochidodromous
9.	*S. spinosa* L.	Hyderabad	Elliptic to ovate	Acute	Obtuse to truncate	Serrate	-do-	-do-	-do-	1	8	Acute	126	52	Pinnate, eucamptodromous

schimperiana (Fig. 6) shows pinnate brochidodromous pattern. On the other hand, *S. cordifolia, S. mysorensis*, and *S. cordata* (Figs. 7 – 9) exhibit actinodromous perfect and basal condition.

In all the taxa studied, the venation is resolved up to quinternary (5°). For the sake of convenience, the observations are presented under different heads, as given below.

MAJOR VEINS:

Primary veins (1°): The primary vein is the thickest, either occurring singly (in all pinnate taxa; Figs. 1 – 6) or four to seven in number (in all actinodromous taxa; Figs. 7 – 9). They run straight in all taxa. The size of the primary vein in all the taxa is weak ($< 1\%$)

Secondary veins (2°): They are the next smaller class of veins arising from the primary vein(s). The angle of divergence is at acute moderate angle (45° – 60°). However, in *S. rhombifolia* var. *retusa, S. grewioides, S. acuta* and *S. schimperiana*, the lower secondaries are more acute than the upper ones. Further, the course is mostly straight, excepting in a few upper secondaries, where it is proximally curved.

MINOR VEINS:

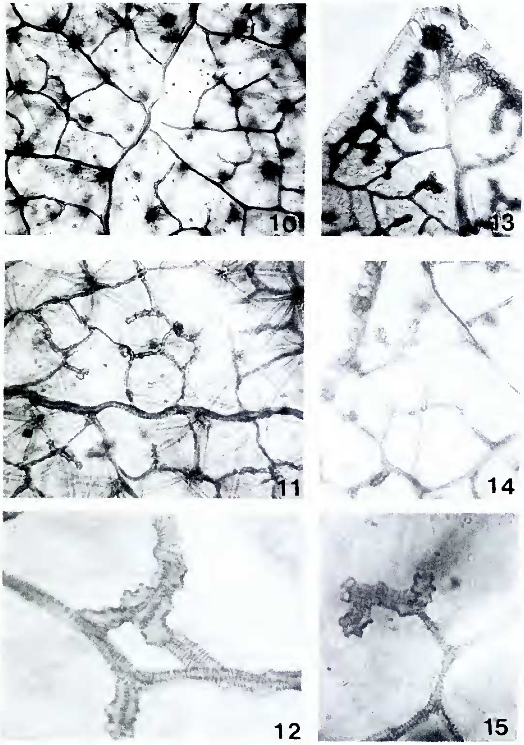
Tertiary veins (3°): They are at right or acute angles (RR & RA), percurrent and they run straight in their course.

Quaternary veins (4°): These veins form areoles in all the taxa studied (Fig. 10). The areoles are well developed and range from quadrangular to rounded in shape (Fig. 11). The number of areoles (per square millimeter) show a wide range and they vary from 19 (*S. rhombifolia* var. *retusa*) to 132 (*S. schimperiana*; Table 1). The course of quaternary veins is orthogonal (Figs. 10 – 11).

Quinternary veins (5°): These are the highest vein order resolved and they end up in the areoles as vein ending (Figs. 10 – 11). The vein endings are simple (both linear and curved; Fig. 12) and branched (once or twice; Fig. 13). The number of vein endings entering the areoles range between six (*S. cordata*) and 74 (*S. schimperiana*; per square millimeter; Table 1).

Tracheoids: They are the terminal points on the vein endings, and present either terminally or on the lateral sides. The tracheoids are either brachytracheoids or tracheoids-in-aggregates (Figs. 13 & 14). However, the tracheoids-in-aggregates are totally absent in *S. schimperiana*.

Bundle sheath: It is seen in all the nine taxa studied. They are present around all the degrees of veins in *S. rhombifolia* var. *retusa* and *S. grewioides*, but encircles only the minor veins in the remaining taxa.



FIGS. 10 – 15: 10. *S. cordifolia*: Quaternary veins forming the areoles, × 95; 11. *S. rhombifolia* var. *rhombifolia*: Well developed areoles ranging from quadrangular to rounded in shape, × 98; 12. *S. mysorensis*: An areole with simple, straight and linear vein endings, × 87; 13. *S. acuta*: Tracheoids-in-aggregates, confined to the margins, × 82; 14. *S. spinosa*: Brachytracheoids, × 82; 15. *S. cordata*: Gamma junction type of vein ending, × 89.

Sphaerocrystals: They are encountered only in *S. grewioides* and *S. schimperiana* and they line all the grades of veins.

Tooth architecture: It is studied in all the species except *S. schimperiana*, where the margin is entire. The teeth are compound, non-glandular with simple apical termination. The principal vein configuration of the tooth is a secondary vein in the bigger teeth. However, in actinodromous species the lateral primaries also enter the bigger teeth.

DISCUSSION

According to Hickey & Wolfe (1975), the leaves of Malvales are simple and venation is of actinodromous type (= Rectipalmatus type of Melville 1976). Recently, Bhat et al. (1988) working on Malvaceae (other than *Sida*) recorded actinodromous and pinnate types of venation. In the present study of *Sida* too, the venation is broadly assignable to actinodromous and pinnate categories.

According to Hickey & Wolfe (1975), the pinnate type might have evolved through the suppression of the lateral primaries of the actinodromous category in the Malvales. In this connection, it is interesting to note that in *S. rhombifolia* var. *rhombifolia*, *S. grewioides* and *S. spinosa* (Figs. 1, 3 & 5), some of the lower secondaries tend to be thicker than the others, but certainly distinct from the midrib. Thus, the above taxa may possibly form a connecting link between pinnate and actinodromous types in *Sida*.

Recently Samant & Shete (1987), working on *Cassia*, advocated a correlation between the plant habit and orders of venation. According to them, the herbs possess 2° veins as their highest vein order and the trees have $5-7^\circ$ as their highest order. In the present study, the highest vein order is uniformly 5° in all the taxa studied. Unlike the herbaceous *Cassia*, the situation in *Sida* is totally different as they are either herbs or undershrubs. Therefore, the present investigation does not favour any correlation between the plant habit and presence of particular order of venation.

As stated earlier, the highest venation order in *Sida* is resolved up to 5° which, however, differs from the observations made earlier in the Malvaceae (Bhat et al. 1988) where it is up to 6°.

Levin (1929) proposed the usage of areole number as a taxonomic tool. In the present investigation also, the number of areoles are found to be species specific (Table 1).

The vein endings in *Sida* are simple (linear & curved; Fig. 12) or branched (once or twice). Of the nine different types of vein endings proposed by Melville (1976), presently gamma type alone is observed (Fig. 15).

The termini of vein endings are either brachytracheoids (Fig. 14) or tracheoids-in-aggregates (Fig. 13). It has been suggested that the presence of tracheoids is an adaption to xeric conditions (Verghese 1969; Kakkar & Paliwal 1972; Sehgal & Paliwal 1974; Mohan & Inamdar 1984). Further, it is also suggested that they may provide mechanical support (Withner et al. 1974; Olatungi & Nengim 1980; Mohan & Inamdar 1984) or help in water retention (DeFraine 1912; Pant & Bhatnagar 1977). The present study also reveals the tracheoids, which may possibly help in the water retention potentialities of *Sida* occurring in dry habitats in India.

According to Bhat et al. (1988), the parenchymatous bundle sheath encloses only the primary and secondary veins in some species of the Malvaceae. In *Sida*, the bundle sheath is encountered on minor veins on all the taxa investigated. However, in *S. rhombifolia* var. *retusa* and *S. grewioides* they are encountered on all the degrees of veins.

The present study puts forth several characteristics of leaf architecture that are diagnostic and help in the identfiication of species.

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REFERENCES

BANERJI, M. L. and SITESH DAS. 1972. Minor venation pattern in the Indian Acers. Advances Pl. Morph. 51 – 52.

BHAT, R. B., J. A. INAMDAR, and D. J. WEBBER. 1988. Leaf architecture of some Malvaceae. Angew. Bot. 62 (3 – 4):135 – 146.

DE FRAINE, E. 1912. The anatomy of genus *Salicornia*. J. Linn. Soc., Bot. 41:317 – 348.

FOSTER, A. S. 1950. Morphology and venation of the leaf of *Quiina acutangula* Ducke. Amer. J. Bot. 37:159 – 171.

_______________. 1951. Heterophylly and foliar venation of the *Lacunaria*. Bull. Torrey Bot. Club 78:382 – 400.

HICKEY, L. J. 1973. Classfiication of the architecture of dicotyledonous leaves. Amer. J. Bot. 60:17 – 35.

_______________. 1979. A revised classification of the architecture of dicotyledonous leaves. *In*: (Eds.) Metcalfe and Chalk, Anatomy of dicotyledons. Clarendon Press, Oxford.

_______________ and J. A. WOLFE. 1975. The basis of angiosperm phylogeny: venation. Ann. Missouri Bot. Gard. 62:538 – 589.

KAKKAR, L. and G. S. PALIWAL. 1972. Studies on the leaf anatomy of *Euphorbia*. VI. The bundle sheath: *In*: (Ed.) V. Puri, Biology of land plants. pp. 71−77. Saritha Prakashan, Meerut, India.

LEVIN, F. A. 1929. The taxonomic value of vein islet areas based upon a study of the genera *Barosma, Cassia, Erythroxylon* and *Digitalis*. J. Pharm. Pharmacol. 2:17−43.

MELVILLE, R. 1976. The terminology of leaf architecture. Taxon 25:549−561.

MOHAN, J. S. S. and J. A. INAMDAR. 1984. Leaf venation studies in some Asclepiadaceae. Phytomorphology 34:36−45.

OLATUNJI, O. A. and R. O. NENGIM. 1980. Occurrence and distribution of tracheoidal elements in the Orchidaceae. J. Linn. Soc., Bot. 80:357−370.

PANT, D. D. and S. BHATNAGAR. 1977. Morphological studies in *Nepenthes*. Phytomorphology 27:13−34.

PRABHAKER, M. and N. RAMAYYA. 1982. Foliar venation patterns and their taxonomic importance in Indian Portulacaceae. Geophytology 12 (1):49−54.

RAO, T. A. and SILPI DAS. 1979. Typology of foliar tracheoids in angiosperms. Proc. Indian Acad. Sci. 90 B:53−58.

SAMANT, D. D. and R. H. SHETE. 1987. Venation patterns in Indian species of *Cassia* L. Proc. Indian Acad. Sci. 97:337−346.

SEHGAL, L. and G. S. PALIWAL. 1974. Studies on the leaf anatomy of *Euphorbia* II: Venation pattern. J. Linn. Soc., Bot. 68:173−208.

TUCKER, SHIRLEY, C. 1964. The terminal idioblasts in magnoliaceous leaves. Amer. J. Bot. 51:1051−1062.

VERGHESE, T. M. 1969. A contribution on the foliar venation in Scrophulariaceae. *In*: (Ed.) K. A. Choudhury, Recent advances in the anatomy of tropical seed plants. pp. 253−266. Hindustan Publishing Co., Delhi.

WITHNER, C. L., P. K. NELSON, and P. J. WEJKSNDRA. 1974. The anatomy of orchids. *In*: (Ed.) C. L. Withner, The orchids: Scientfiic studies. pp. 267−347. John Wiley & Sons, London.